and **308**C. As shown in FIG. **4**C, the shielding layer **410** is exposed by the recesses **308**A, **308**B, and **308**C.

Afterwards, the exposed portions of the shielding layer **410** are removed such that the recesses **308**A, **308**B, and **308**C expose the dielectric layer **406**A, as shown in FIG. **4**D in accordance with some embodiments. An etching process may be performed to remove the exposed portion of the shielding layer **410**. As a result, a dielectric grid constructed by the patterned dielectric layer **406**B is formed, as shown in FIG. **4**D. In some embodiments, each of the recesses **308**A, **308**B, and **308**C is aligned with the photodetectors **106**A, **106**B, and **106**C, respectively.

As shown in FIG. **4**E, filters such as the color filters **310**R, **310**B, and **310**G are respectively formed in the recesses of the dielectric layer **406**B (or dielectric grid), in accordance with some embodiments. As shown in FIG. **4**E, the shielding layer **410** surrounds the color filters **310**R, **310**B, and **310**G. The color filters **310**R, **310**B, and **310**G may be made of a dye-based polymer (or a pigment-based polymer). In some embodiments, a first filter film is deposited over the dielectric layer **406**B to fill the recesses **308**A, **308**B, and **308**C using, for example, a spin-on process or other applicable processes. The first filter film may also be a photoresist layer. Therefore, exposure and development operations may then be performed to pattern the first filter film such that the first filter film remains in one of the recesses, such as the recess **308**A. As a result, the color filter **310**R is formed. Similarly, the color filters **310**B and **310**G may be formed sequentially by using similar methods.

In some embodiments, the color filters **310**R, **310**B, and **310**G have protruding portions **311**R, **311**B, and **311**G, respectively. Each of the protruding portions **311**R, **311**B, and **311**G protrudes from a bottom surface **407** of the dielectric layer **406**B. The protruding portions **311**R, **311**B, and **311**G are surrounded by the shielding layer **410**, as shown in FIG. **4**E in accordance with some embodiments. In some embodiments, a bottom of the shielding layer **410** is substantially coplanar with bottoms of the color filters **310**R, **310**B, and **310**G, as shown in FIG. **4**E.

After the formation of the color filters, the lenses **312**A, **312**B, and **312**C are respectively formed over the color filters **310**R, **310**B, **310**G, as shown in FIG. **4**E in accordance with some embodiments. As shown in FIG. **4**E, an incident light L_3 is directed by the lens **312**A and enters the color filter **310**R in some embodiments. The incident light L_3 is reflected by the sidewall of the recess **308**A and sensed by the photodetector **106**A in the pixel region **101**A. An incident light L_4, similar to the incident light L_2 shown in FIG. **3**, is blocked by the shielding layer **410** from entering the pixel region **101**B adjacent to the pixel region **101**C. Therefore, substantially no non-filtered signals are sensed by the photodetectors. The crosstalk problem is also prevented or significantly reduced. The performance and reliability of the image sensor device **100'** are improved.

Embodiments of mechanisms for forming an image sensor device are provided. A shielding layer is formed between color filters of the image sensor device. Due to the shielding layer, substantially no non-filtered signals enter the photodetectors, and the crosstalk problem is prevented or significantly reduced. The yield and performance of the image sensor device are therefore improved.

In accordance with some embodiments, an image sensor device is provided. The image sensor device includes a semiconductor substrate and a photodetector in the semiconductor substrate. The image sensor device also includes a dielectric layer over the semiconductor substrate, and the dielectric layer has a recess aligned with the photodetector. The image sensor device further includes a filter in the recess of the dielectric layer. In addition, the image sensor device includes a shielding layer between the dielectric layer and the semiconductor substrate and surrounding the filter.

In accordance with some embodiments, an image sensor device is provided. The image sensor device includes a semiconductor substrate having a first pixel region and a second pixel region. The image sensor device also includes a first photodetector and a second photodetector in the first pixel region and the second pixel region, respectively. The image sensor device further includes a dielectric layer over the semiconductor substrate, and the dielectric layer has a first recess and a second recess aligned with the first photodetector and the second photodetector, respectively. In addition, the image sensor device includes a first filter and a second filter in the first recess and the second recess, respectively. The image sensor device also includes a shielding layer between the dielectric layer and the semiconductor substrate and surrounding the first filter and the second filter.

In accordance with some embodiments, a method for forming an image sensor device is provided. The method includes forming a photodetector in a semiconductor substrate and forming a shielding layer over the semiconductor substrate. The method also includes forming a dielectric layer over the shielding layer and partially removing the dielectric layer to form a recess. The method further includes partially removing the shielding layer through the recess and forming a filter in the recess after the shielding layer is partially removed.

Although the embodiments and their advantages have been described in detail, it should be understood that various changes, substitutions, and alterations can be made herein without departing from the spirit and scope of the embodiments as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods, and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed, that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the disclosure. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps. In addition, each claim constitutes a separate embodiment, and the combination of various claims and embodiments are within the scope of the disclosure.

What is claimed is:

1. An image sensor device, comprising:

a semiconductor substrate;

a photodetector in the semiconductor substrate;

a dielectric layer over the semiconductor substrate, wherein the dielectric layer has a recess aligned with the photodetector;

a filter in the recess of the dielectric layer, wherein the filter has a protruding portion protruding from a bottom surface of the dielectric layer;

a shielding layer between the dielectric layer and the semiconductor substrate and surrounding the filter, wherein the filter and the shielding layer overlap from a view facing a direction perpendicular to a normal direction of a top surface of the semiconductor substrate, and the shielding layer surrounds the protruding portion of the filter; and